

APPENDIX C

GEOTECHNICAL

The Oxbow-Riverside Drive study considers the impacts of constructing a multi-purpose park and wetland within a 170-acre parcel along the Trinity River. The study area is located east of downtown Fort Worth on the West Fork of the Trinity River. The largest portion of the study area lies downstream of Riverside Drive, extending to a point just downstream of Beach Street. The reach includes the old West Fork channel, which formed an oxbow when the channel was realigned.

General Geological Features The Oxbow-Riverside study area lies within the Trinity River alluvium overlying the Fort Worth Limestone and Duck Creek Formation undivided. The alluvium consists of sands, sandy clays, and gravel that were deposited by the river. The underlying primary materials are formations of calcareous clay and limestone that were deposited in a sedimentary geologic environment during the Cretaceous Period.

According to the Soil Survey of Tarrant County, Texas the soil unit in the study area belongs to the Frio-Trinity series. The Frio series consists of well-drained, deep clayey soils that were formed in calcareous, recent alluvium. Typical pedon consists of moderately alkaline, dark grayish brown silty clays that are plastic, firm to very hard, moderately fine, and have a medium blocky structure. The underlying soil is a moderately alkaline, silty clay loam that is plastic, dark brown to brown, very hard, moderately fine, and has a medium subangular blocky structure. The permeability of the Frio soil is moderately slow and the available water capacity is high. Generally, these soils are well suited for use as cropland, pastureland, and are moderately suited for most recreational uses. The main limitation of the Frio soils is the hazard to flooding.

Morphology The majority of the Oxbow is in its natural state in that the channel banks are fairly steep and covered with natural vegetative growth. Flow from the Trinity River has been cut off to the Oxbow and now the only means of water accumulation is from surface runoff. A slight meandering of the channel has allowed the build-up of alluvial soils that were deposited during flood events. Most of the Trinity River channel in the study area has been modified to provide a higher level of flood protection. The channel banks along this reach were constructed from native soils and on 3H:1V slopes. The embankments are grass covered and well maintained. The river is generally non-meandering, which has limited surface erosion and scouring of the channel sides and bottom. Sedimentation build-up within the channel bottom is minimal.

Existing Geological Investigations The U.S. Army Corps of Engineers, Fort Worth District (COE), through its contractor Tetra Tech NUS, Incorporated, performed a geotechnical investigation at various locations within the study area in early May 2002, as described below in "Geotechnical Studies." A geotechnical investigation performed by Mas-Tek Engineering & Associates, Incorporated, for the design and construction of a low water dam that is being built approximately 700 feet downstream of the Beach Street Bridge, was also reviewed. For the purpose of this report, geological features will be delineated using the May 2002 Corps of Engineers field investigation, and the Mas-Tek Engineering report, as well as information from the University of Texas, Bureau of Economic Geology and the Soil Survey of Tarrant County, Texas.

Geotechnical Studies A geotechnical field investigation was performed under contract by Tetra Tech NUS, Incorporated (Houston, Texas), and their drilling subcontractor, Groundwater

Monitoring, Incorporated, in early May 2002, at the locations of the Riverside Drive bridge (subsequently deleted from the project), Beach Street bridge, the proposed upstream and downstream levee bridges, and the proposed parkroad bridge. The purpose of the investigation was to identify subsurface conditions and obtain representative soil and rock samples for laboratory testing. Groundwater Monitoring, Incorporated, used a truck-mounted drill rig, model CME-75, to accomplish drilling for the field investigation. Hollow-stem 6-inch O.D./2.25-inch I.D. continuous flight augers were used to advance the borings, while 2-inch (O.D.) split spoon samplers were used to collect disturbed overburden soil samples, 3-inch (O.D.) thin walled shelly tube samplers were used to collect undisturbed overburden samples, and a 3-inch O.D./2.125-inch I.D. NX core barrel was used to collect rock core samples.

For the purpose of this report, results of the field investigation and laboratory testing programs were used to characterize the foundation conditions for new bridge construction. In addition, the competency of the existing and proposed embankments and levees were evaluated, along with proposed channel construction. It should be noted that where a difference existed between the field visual description of a soil stratum (as depicted on the logs of borings) and the laboratory classification of that material, the laboratory classification was generally used in the site subsurface condition descriptions presented below.

Subsurface Conditions at the Riverside Drive Bridge Two COE boreholes, designated 8A4C-1 and 8A4C-2, were drilled adjacent to the Riverside Drive bridge. The locations of these two borings are presented on Plate G-1, located in Appendix B.

Boring 8A4C-1 was drilled on the south side of the Trinity River, approximately 100 feet west of the bridge abutment, and advanced to a total depth of 63 feet. The surveyed ground surface elevation at the location of boring 8A4C-1 was determined to be 505.75 feet above mean sea level (msl) using global positioning satellite (GPS) survey equipment. Soils encountered within boring 8A4C-1 consisted of 53 feet of interbedded alluvial deposits, overlying shale and limestone primary. A stiff to very stiff, damp, sandy, silty, brown low plasticity (field visual description) clay was encountered from the surface to a depth of 14 feet, beneath which a three-foot thick layer of medium stiff, moist, brown clayey silt occurs, underlain by a three-foot thick layer of loose, fine-grained, moist, silty sand. A medium stiff, moist to wet (at 22 feet), brown, clayey, slightly plastic (field visual description) silt to silty clay, occurs beneath the sand to a depth of 40 feet, and grades into a brown silty sand in the lower 8 feet of the deposit. This lower sand layer, 13 feet in thickness, grades between coarser and finer grain sizes, with varying amounts of gravel, silt, and clay, and probably constitutes a meandering channel depositional sequence. Very stiff, fossiliferous dark gray clay shale, interbedded with limestone seams, was encountered at a depth of 53 feet, and continued to the total depth of boring advancement (63 feet), at which point hard limestone was encountered, resulting in auger refusal.

Disturbed soil samples, stored in jars, and undisturbed 2-inch diameter shelly tube samples were collected from the overburden and primary (shale) materials encountered within boring 8A4C-1. Undisturbed samples were subjected to laboratory testing for identification, moisture content, grain size distribution, Atterberg limits, dry unit weight, shear strength (unconsolidated-undrained triaxial test), and consolidation. The silty clay/clayey silt deposited directly above the sand stratum was found to have a dry unit weight of 106.1 pounds per cubic foot, a liquid limit of 36 percent, a plasticity index of 23 percent, a field moisture content of 21.7 percent, and an undrained shear strength of 1,760 pounds per square foot. A sample recovered from the lower sand stratum was determined to have a dry unit weight of 104.6 pounds per cubic foot and a field moisture content of 14.6 percent. A

specimen of the clay shale primary was determined to have a dry unit weight of 106.5 pounds per cubic feet, a field moisture content of 19.9 percent, a liquid limit of 60 percent and a plasticity index of 34 percent.

Boring 8A4C-2 was drilled on the north side of the Trinity River, approximately 120 feet west of the bridge abutment, and advanced to a total depth of 70 feet. The surveyed ground surface elevation at the location of boring 8A4C-2 was determined to be 505.78 feet msl using global positioning satellite (GPS) survey equipment. Soils encountered within boring 8A4C-2 consisted of 57 feet of interbedded alluvial deposits, similar to those encountered in boring 8A4C-1, overlying shale and limestone primary. A medium stiff to very stiff, damp, sandy, silty, light brown to dark brown low plasticity (field visual description) clay was encountered from the surface to a depth of 12 feet. Gravel and bits of asphalt were noted in the clay between approximately 9 feet and 12 feet below ground surface, indicating that the clay may be a fill deposit. Below the clay is a medium stiff to stiff, damp to wet (at 20 feet), brown, iron-stained, clayey, sandy silt, which occurs to a depth of 44 feet. A silty, sandy gravel stratum, measuring 13 feet in thickness, and composed of rounded to subangular grains with a maximum diameter of 1 inch, was encountered below the clayey silt layer, and directly above a clay shale primary, similar to that identified in boring 8A4C-1. Horizontal fractures were noted in core specimens of the shale. The borehole was terminated at a depth of 70 feet without encountering a limestone bed thick enough to cause auger refusal.

The overburden and primary materials encountered within boring 8A4C-2 were very similar to those encountered in boring 8A4C-1, and no samples collected from the second boring were subjected to laboratory testing.

Groundwater was encountered in boring 8A4C-1 during drilling within the clayey silt/silty clay layer at a depth of 29 feet, and a static water level was measured at about 17 feet below ground surface (approximate elevations 477 feet msl and 489 feet msl, respectively). Groundwater was encountered within boring 8A4C-2 during drilling within the clayey silt layer at a depth of 20 feet, and a static water level was recorded at a depth of about 18 feet below ground surface (approximate elevations 486 feet msl and 488 feet msl, respectively). It should be noted, however, that groundwater conditions are relative to the time of drilling, annual precipitation, river elevation, and drainage conditions at the site.

Logs of boring for 8A4C-1 and 8A4C-2 are presented after the “Design Assumptions” section at the end of this Appendix.

Subsurface Conditions at the Proposed Upstream Levee Bridge One COE borehole, designated 8A4C-3, was drilled at the location of the proposed upstream levee bridge, as presented on Plate G-1

Boring 8A4C-3 was drilled on the north side of the Trinity River, immediately south of the oxbow inlet, and advanced to a total depth of 60 feet. The surveyed ground surface elevation at the location of boring 8A4C-3 was determined to be 502.45 feet msl using global positioning satellite (GPS) survey equipment. Alluvial clays, silts, sands, and gravel only were encountered within boring 8A4C-3 – primary was not contacted. Medium stiff to stiff, damp, brown, silty high plasticity (laboratory classification) clay extends from the surface to a depth of 13 feet. The clay becomes more sandy and less plastic below 13 feet. A medium stiff, damp to wet (at approximately 22 feet), gray silty low plasticity (laboratory classification) clay with an organic odor is encountered at a depth of 20 feet, and

continues to a depth of approximately 35 feet. Below the silty clay, and extending to the total borehole depth, is a stratum of medium coarse to coarse, loose, subrounded sand, with varying amounts of gravel, silt, and clay. Wood debris was noted within the sand stratum. A layer of loose subrounded gravel, measuring approximately 3 feet in thickness, occurs within the sand at a depth of 55 feet.

Disturbed soil samples, stored in jars, were collected from the alluvial overburden materials encountered within boring 8A4C-3. The disturbed samples were subjected to laboratory testing for identification, moisture content, grain size distribution, and Atterberg limits. A sample collected from the surficial clay layer was found to have a liquid limit of 53 percent, a plasticity index of 32 percent, and a field moisture content of 20.7 percent. Samples of the clay taken below 13 feet (the more sandy zone) were determined to have liquid limits between 29 and 40 percent, plasticity indices between 13 and 20 percent, and field moisture contents between 17.4 and 30.4 percent. The sand was found to be generally non-plastic, although the deepest sand specimen, collected in a more clayey interval between 58 feet and 60 feet below ground surface, exhibited a liquid limit of 32 percent and a plasticity index of 18 percent. Field moisture contents measured within the sand varied between 5.9 percent (gravelly zone) and 17.2 percent.

Groundwater was encountered in boring 8A4C-3 during drilling within the clayey silt/silty clay layer at a depth of 30 feet, and a static water level was measured at about 22 feet below ground surface (approximate elevations 472 feet msl and 480 feet msl, respectively). It should be noted, however, that groundwater conditions are relative to the time of drilling, annual precipitation, river elevation, and drainage conditions at the site.

A boring log for 8A4C-3 is presented after the "Design Assumptions" section at the end of this Appendix.

Subsurface Conditions at the Beach Street Bridge Two COE boreholes, designated 8A4C-4 and 8A4C-5, were drilled adjacent to the Beach Street bridge crossing the oxbow. The locations of these two borings are presented on Plate G-1

Boring 8A4C-4 was drilled immediately west of the bridge on the north side of the oxbow, and advanced to a total depth of 35 feet. The surveyed ground surface elevation at the location of boring 8A4C-4 was determined to be 505.74 feet msl using global positioning satellite (GPS) survey equipment. Soils encountered within boring 8A4C-4 consisted of approximately 8 feet of alluvial overburden materials overlying interbedded shale and limestone primary. Stiff, damp, brown, low plasticity (field visual description) silty clay/clayey silt, with variable amounts of sand and gravel, occurs from the surface to a depth of approximately 8 feet. Beneath these surficial clays and silts is a horizon of light brown, interbedded weathered shale and limestone. The shale has a soft to medium stiff, low plasticity (field visual description) clay consistency; limestone beds are thin. Gray unweathered shale and limestone primary was encountered at a depth of 22.5 feet, and was present to the total boring depth. Horizontal fractures were noted within the shale.

Disturbed overburden soil samples, stored in jars, and 2-inch diameter rock core samples were collected within boring 8A4C-4. No undisturbed samples were tested. However, rock core specimens of the limestone primary were subjected to laboratory testing for dry unit weight, moisture content, and unconfined compressive strength. Dry unit weight of the limestone specimens varied from 125.4 pounds per cubic foot to 147.7 pounds per cubic foot. Moisture contents ranged from 5.2 percent

to 10.3 percent. Unconfined compressive strengths for the limestone core specimens varied from 57.5 tons per square foot, to 136.7 tons per square foot.

Boring 8A4C-5 was drilled immediately east of the bridge on the south side of the oxbow, and advanced to a total depth of 60 feet. The surveyed ground surface elevation at the location of boring 8A4C-2 was determined to be 512.03 feet msl using global positioning satellite (GPS) survey equipment. Soils encountered within boring 8A4C-5 consisted of 10 feet of fill, placed atop 48.5 feet of alluvial sands, silts, clays, and gravels, overlying limestone primary. A surficial fill layer was encountered from the surface to a depth of 10 feet. The fill is a mixture of clayey, sandy, gravelly, silty soil, mixed with construction debris including bricks, concrete, wood, and wires. Beneath the fill is a stratum of loose, coarse, damp, brown silty sand, which extends to a depth of approximately 32 feet. A deposit of soft to stiff, gray, low plasticity (laboratory classification) clay, with sand and silt was encountered below the sand stratum to a depth of 56 feet, at which point a gravel stratum, measuring 2.5 feet in thickness, with cobbles and sand, was contacted. Gray and yellow brown limestone primary was encountered below the gravel layer, and penetrated to a depth of 60 feet below ground surface (i.e., 1.5 feet of total penetration into primary).

Disturbed overburden soil samples, stored in jars, were collected within boring 8A4C-5. No undisturbed samples were collected for testing. The disturbed soil samples were subjected to laboratory testing for identification, moisture content, grain size distribution, and Atterberg limits. Field moisture contents measured in samples collected within the sand stratum varied from 7.5 percent to 26.2 percent. One sand specimen with a higher clay content was determined to have a liquid limit of 29 percent and a plasticity index of 12 percent, while two other sand specimens were found to be non-plastic. Disturbed samples from the clay horizon were determined to have moisture contents ranging from 22.0 percent to 26.7 percent, liquid limits ranging from 31 percent to 43 percent, and plasticity indices varying from 16 percent to 28 percent.

A static groundwater level was established within boring 8A4C-4 at a depth of 0.94 feet (approximate elevation 505 feet). Groundwater was encountered in boring 8A4C-5 during drilling within the sand stratum at a depth of 30 feet, and a static water level was measured at about 17 feet below ground surface (approximate elevations 482 feet msl and 495 feet msl, respectively). It should be noted, however, that groundwater conditions are relative to the time of drilling, annual precipitation, river elevation, and drainage conditions at the site.

Logs of boring for 8A4C-4 and 8A4C-5 are presented after the “Design Assumptions” section at the end of this Appendix.

Subsurface Conditions at the Proposed Downstream Levee Bridge One COE borehole, designated 8A4C-6, was drilled at the location of the proposed downstream levee bridge, as presented on Plate G-1.

Boring 8A4C-6 was drilled on the north side of the Trinity River, approximately 340 feet east of the Beach Street bridge, and advanced to a total depth of 60 feet. The surveyed ground surface elevation at the location of boring 8A4C-6 was determined to be 526.95 feet msl using global positioning satellite (GPS) survey equipment. Soils encountered within boring 8A4C-6 consisted of four feet of fill, placed atop 55.5 feet of alluvial clay and gravel, overlying limestone and shale primary. The fill was described as silty clay with sand and gravel, containing concrete. Below the fill layer, a medium stiff to very stiff, damp to wet (at 30 feet), brown, silty, sandy clay horizon was encountered to a depth

of 58 feet below ground surface. The clay was determined, by laboratory testing, to be high plasticity above a depth of approximately 26 feet below ground surface, and low plasticity below that point. A thin stratum of saturated clayey gravel with sand, with a total thickness of 1.5 feet, was penetrated below the clay horizon. Interbedded gray limestone and shale was contacted beneath the gravel interval.

Disturbed soil samples, stored in jars, and undisturbed 2-inch diameter shelly tube samples were collected from the overburden materials encountered within boring 8A4C-6. Disturbed samples were subjected to laboratory testing for identification, moisture content, grain size distribution, and Atterberg limits. Undisturbed samples were tested for determination of dry unit weight and shear strength (unconsolidated-undrained triaxial test), as well. As previously noted, clay specimens collected above an approximated depth of 26 feet below ground surface, were determined to be highly plastic, with liquid limits ranging from 55 percent to 62 percent and plasticity indices varying from 35 percent to 45 percent; moisture contents for these specimens ranged from 12.8 percent to 20.5 percent. Clay specimens collected below 26 feet were found to have liquid limits between 26 percent and 33 percent, plasticity indices between 10 percent and 21 percent, and moisture contents ranging from 20.4 percent to 23.4 percent. Furthermore, these (lower) clays were determined to have dry unit weights between 100.8 pounds per cubic foot and 108.9 pounds per cubic foot, and undrained shear strengths between 291 pounds per square foot and 3,560 pounds per square foot. A disturbed sample collected from the basal clayey gravel layer was also tested, and found to have a liquid limit of 26 percent, a plasticity index of 14 percent and a moisture content of 8.1 percent.

Groundwater was encountered in boring 8A4C-6 during drilling within the clayey silt/silty clay layer at a depth of 30 feet, and a static water level was measured at about 25 feet below ground surface (approximate elevations 497 feet msl and 502 feet msl, respectively). It should be noted, however, that groundwater conditions are relative to the time of drilling, annual precipitation, river elevation, and drainage conditions at the site.

A boring log for 8A4C-6 is presented after the “Design Assumptions” section at the end of this Appendix.

Subsurface Conditions at the Parkroad Bridge One COE borehole, designated 8A4C-7, was drilled at the location of the proposed parkroad bridge, as presented on Plate G-1.

Boring 8A4C-7 was drilled on the south side of the oxbow, approximately 600 feet upstream of the confluence with the Trinity River, and advanced to a total depth of 52 feet. The surveyed ground surface elevation at the location of boring 8A4C-7 was determined to be 506.08 feet above mean sea level (msl) using global positioning satellite (GPS) survey equipment. Soils encountered within boring 8A4C-7 consisted of 3 feet of fill, placed atop 49 feet of alluvial clay, sand, and gravel. The fill was described as clay and silt mixed with wood and organic debris, as well as metal and plastic. Below the fill layer is a medium stiff, damp to wet (at 27 feet), gray to brown, clay horizon containing plant roots. The clay was determined, by laboratory testing, to be high plasticity above a depth of approximately 35 feet below ground surface, and low plasticity below that point, to a depth of approximately 40 feet below ground surface (base of the clay horizon). Caliche was noted filling fractures within the clay. A loose, silty, clayey, gravelly, gray, saturated sand stratum was encountered below the clay interval, and continued to the total boring depth. The sand became more gravelly below an approximate depth of 47 feet.

Disturbed soil samples, stored in jars, and undisturbed 2-inch diameter shelly tube samples were collected from the overburden materials encountered within boring 8A4C-7. Disturbed samples were subjected to laboratory testing for identification, moisture content, grain size distribution, and Atterberg limits. Undisturbed samples were tested for determination of dry unit weight and shear strength (unconsolidated-undrained triaxial test), as well. As previously noted, clay specimens collected above an approximated depth of 35 feet below ground surface, were determined to be highly plastic, with liquid limits ranging from 50 percent to 56 percent and plasticity indices varying from 33 percent to 34 percent; moisture contents for these specimens ranged (narrowly) between 21.2 percent to 21.4 percent. A clay specimen collected below 35 feet was found to have a liquid limit of 29 percent, a plasticity index of 12 percent, and a moisture content of 23.1 percent. Dry unit weight and undrained shear strength for this lower clay were determined to be 103.4 pounds per cubic foot and 204.0 pounds per square foot, respectively. A specimen of the clayey sand with silt was determined to have a liquid limit of 20 percent, a plasticity index of 7 percent, a moisture content of 21.4 percent, and a dry unit weight of 107.2 pounds per cubic foot.

Groundwater was encountered in boring 8A4C-7 during drilling within the clayey silt/silty clay layer at a depth of 27 feet, and a static water level was measured at about 21 feet below ground surface (approximate elevations 479 feet msl and 485 feet msl, respectively). It should be noted, however, that groundwater conditions are relative to the time of drilling, annual precipitation, river elevation, and drainage conditions at the site.

A boring log for 8A4C-7 is presented after the "Design Assumptions" section at the end of this appendix.

Subsurface Conditions at the Low Water Dam (By Others) Mas-Tek Engineering & Associates performed a subsurface investigation at the low water dam site. Two boreholes were drilled at the dam site, one on each side of the Trinity River. The boring drilled on the north side of the river was advanced to a depth of 50 feet and the boring drilled on the south side was advanced to a total depth of 40 feet. Undisturbed cohesive soil samples were collected using seamless tube samplers and standard penetration testing was performed within the non-cohesive materials encountered in each test hole. Representative soil samples were subjected to laboratory testing for identification, moisture content, grain size distribution, Atterberg limits, and dry unit weight. Undisturbed samples were subjected to shear strength and consolidation testing as well.

Soils encountered in the boring drilled on the north side of the river consist of an initial 6-foot layer of very stiff to hard, dark brown clay. Underlying the clay is a 3-foot layer of tan to light brown sandy gravel and a deeper deposit of dark brown to brown clay. The clay transitions from hard to soft with increasing depth and is present to depths of 9 to 43 feet. The last soil feature is a gray, soft, and very wet sand that was present to the total depth investigated, 50 feet.

Subsurface conditions encountered on the south side of the river consist of a surface layer of hard, dark brown gravelly clay to a depth of 3 feet. Beneath the clay is a brown, very stiff to hard clay deposit that extends to an approximate depth of 20 feet. From depths of 20 to 30 feet, the clay becomes slightly sandy and soft, and below 30 feet, the clay becomes very moist to wet. The final soil feature encountered is a tan to light brown sandy clay/clayey sand. This material was penetrated at a depth of 37 feet and is present to the total depth investigated, 40 feet.

Groundwater seepage was noted at the time of drilling at depths of 27 and 28 feet on the north and south sides of the river, respectively. Static levels measured just prior to backfilling the boreholes were 24 feet on the north side and 22 feet on the south side of the river.

Design Assumptions The following foundation, pavement, and embankment design assumptions are provided for the development of project alternatives. The assumptions are based on the aforementioned geotechnical studies and engineering judgment.

New Bridge Structures. The proposed bridge structures should be supported on reinforced concrete straight-shaft drilled piers. Based on subsurface information generated from the COE and Mas-Tek field investigations and laboratory testing data, the piers for the Beach Street bridge, parkroad bridge, and downstream levee bridge should be founded 60 feet below ground surface. Piers for the upstream levee bridges should be founded 70 feet below ground surface. Tentatively, an allowable end bearing capacity of 30,000 psf (net) should not be exceeded when sizing the pier shafts. The piers can be sized for both end bearing and skin friction if additional load-carrying capacity is required. For this phase of design, an allowable side shear value of 650 psf can be used over the effective embedment length of the pier. The effective length (L_{eff}) starts 10 feet below ground surface and extends to within one shaft diameter of the final bearing depth. All pier shafts should be a minimum of 18 inches in diameter and reinforced with a minimum of 1 percent reinforcing steel. The load used to size the piers should consist of full dead load plus that portion of the live load that acts more or less continuously, usually 50 percent.

Small Support-type Structures. Small support-type structures can be supported on reinforced concrete slabs-on-grade with turned-down edge beams. The turned-down edge beam should extend a minimum of 12 inches below outside finished grade and can be sized for a safe bearing pressure of 2,000 psf (net). Interior beams should be spaced on (maximum) 15-foot centers. Subgrade preparation should consist of providing a minimum of 36 inches of compacted nonexpansive fill below the soil-supported slab.

Embankment Construction. The roadways leading to the bridge structures and the proposed levees should be constructed using compacted satisfactory fill materials. The fill can be obtained from on-site excavations or from approved borrow areas. Satisfactory fill includes materials classified in ASTM D 2487 as GW, GM, GC, GP, SW, SP, SM, SC, CL and CH and shall be free of trash, debris, roots, or other organic matter, or stones larger than 3 inches in any dimension. If a CH material is utilized, it shall be stabilized to a maximum liquid limit of 55 percent and a maximum plasticity index of 20 percent. To prepare the subgrade for placement of fill materials, a minimum of 6 inches of existing materials should be removed and replaced with satisfactory backfill material. Placement of satisfactory fill should be in horizontal layers not exceeding 8 inches in loose thickness. Embankments should be constructed such that a 3H to 1V slope is not exceeded when slope protection (riprap) is not provided. Where concrete slope protection is employed, a maximum slope of 1-1/2H to 1V slope should not be exceeded.

Below-Grade Structures and Dewatering. The following information is provided for the design of all below-grade structures, if applicable. All structures should be designed for at-rest conditions using a lateral earth pressure coefficient (k_o) equal to 0.7. In addition, an allowable bearing capacity of 1,500 psf and a cohesion value (c) of 100 psf should be used. All backfill should be nonexpansive material and can be assumed to have a moist unit weight of 125 pcf.

Seasonal groundwater fluctuations within the overburden materials may cause problems with deep excavations. The presence of groundwater should be controlled to prevent sloughing of excavation slopes and walls, and to eliminate interference with the orderly progress of construction. To this end, control measures should be taken in the form of French drains, sumps, ditches or trenches to alleviate the construction area of groundwater and maintain the integrity of the in situ materials.

Pavement Structures. The pavement designs presented below are based on criteria contained in TM 5-822-5/AFM 88-7, Chapter 1, TM 5-822-2/AFM 88-7, Chapter 5, and the geotechnical studies presented in this report. The pavement sections can be used for new park road construction and approaches to the new vehicular bridges. The designs consider CBR values of 5 percent for the raw subgrade when compacted to 90 percent of laboratory maximum density, and 20 percent for the Subbase Course when compacted to 95 percent.

Park Roads (Flexible). Use a design index of 2 for Category II traffic and a Class E street.

1-1/2" Hot-Mix Surface Course

6" Aggregate Base Course compacted to at least 100 percent of maximum laboratory density (ASTM D 1557)

6" Subbase Course compacted to at least 95 percent of maximum laboratory density (ASTM D 1557)

6" Raw Subgrade compacted to at least 90 percent of maximum laboratory density (ASTM D 1557)

Bridge Approaches (Flexible). Use a design index of 5 for Category IVA traffic and a Class D street.

2-1/2" Hot-Mix Surface Course

8" Aggregate Base Course compacted to at least 100 percent of maximum laboratory density (ASTM D 1557)

8" Subbase Course compacted to at least 95 percent of

maximum laboratory density (ASTM D 1557)

6" Raw Subgrade compacted to at least 90 percent of maximum laboratory density (ASTM D 1557)

Bridge Approaches (Rigid). Use a design index of 5 for Category IVA traffic and a Class D street, a modulus of subgrade reaction of 100 pci, and a concrete flexural strength of 650 psi at 28 days.

6" Portland Cement Concrete reinforced with No. 4 bars spaced 16 inches o.c.e.w.

6" Aggregate Base Course compacted to at least 95 percent of maximum laboratory density (ASTM D 1557)

6" Raw Subgrade compacted to at least 90 percent of maximum laboratory density (ASTM D 1557)


Conclusion The area and site-specific geological and soil conditions have been examined through a map and literature review, and through analysis of data generated through field investigation and laboratory testing programs conducted at the locations of each of the currently identified bridge structures to be included in the project. The results of the field investigation and laboratory testing programs were used to characterize the foundation conditions for new bridge construction. Further, the competency of the existing and proposed embankments and levees were evaluated, along with proposed channel construction. Geotechnical design recommendations have been provided for these features. Additional geotechnical studies may be necessary, depending on the project alternatives identified, or if new design features are added.

LOGS OF BORING

Riverside Oxbow Interim Feasibility Study - C-13

Riverside Oxbow Interim Feasibility Study - C-15

BOREHOLE NUMBER: 8A4C-2 Page 1 of 5						
LATITUDE: 32° 45' 2.853" N LONGITUDE: 97° 18' 14.018" W ELEVATION/DATUM: 505.783' M.S.L.						
PROJECT INFORMATION			DRILLING INFORMATION			
PROJECT: Riverside Oxbow JOB NUMBER: N7551.042D LOGGED BY: K. Bell PROJECT MANAGER: M. Meenan DATE DRILLED: 05-09-02			DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson RIG TYPE: CME-75 METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube/10' x 2" Core Barrel TOTAL DEPTH: 70'			
NOTES:			20.00' ∇ Initial Water Level 05-09-02 17.67' ∇ Static Water Level 05-10-02			
DEPTH (Feet)	SOIL SYMBOLS	USCS: SOIL DESCRIPTION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION
0		Surface-wet, gravel, dirt road bed.	RO-8A4C2-SO-0002			
	CL	Sandy, Silty Clay-brown, non-plastic, stiff, damp, roots.		60/54		
-5			RO-8A4C2-SO-0507			
	CL	Silty Clay-brown, non-plastic, stiff to medium stiff, brittle. Light brown from 6-7'; soft, loose, shell fragments, little caliche.		60/60		
-10			RO-8A4C2-SO-1012			
	CL	Gravelly Clay-dark brown, very stiff, iron staining, non-plastic, damp, shell fragments, small asphalt pieces.		60/42		
-15						
	ML	Clayey Silt-grades from tan to brown at 15', grades from medium stiff and damp to stiff, brittle and wet at 15', iron staining.				

SITE MANAGER: M. MEENAN CHECKED BY: K. BELL DRAWN BY: J. FLESCH DATE: 05-16-02 SCALE: N/A CAD DWG. NO.: 8A4C-2 PROJ. NO.: N7551.042D	 TETRA TECH NUS, INC. Houston, Texas	RIVERSIDE OXBOW FORT WORTH, TEXAS SOIL BORING LOG
--	---	--

Riverside Oxbow Interim Feasibility Study - C-18

Riverside Oxbow Interim Feasibility Study - C-19

Riverside Oxbow Interim Feasibility Study - C-22

Riverside Oxbow Interim Feasibility Study - C-23

Riverside Oxbow Interim Feasibility Study - C-24

Riverside Oxbow Interim Feasibility Study - C-25


Riverside Oxbow Interim Feasibility Study - C-27

BOREHOLE NUMBER: 8A4C-5 Page 1 of 4						
LATITUDE: 32° 45' 20.135" N LONGITUDE: 97° 17' 18.339" W ELEVATION/DATUM: 512.031' M.S.L.						
PROJECT INFORMATION			DRILLING INFORMATION			
PROJECT: Riverside Oxbow JOB NUMBER: N7551.042D LOGGED BY: K. Bell PROJECT MANAGER: M. Meenan DATE DRILLED: 05-07-02			DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson RIG TYPE: CME-75 METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon TOTAL DEPTH: 60'			
NOTES:			30.00' ▽ Initial Water Level 05-07-02 16.60' ▼ Static Water Level 05-10-02			
DEPTH (Feet)	SOIL SYMBOLS	USCS: SOIL DESCRIPTION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION
0		Surface-fill material, bricks, gravel, topsoil.	RO-8A4C5-SO-0002			
				60/42		
-5	FILL	Fill Material-brown, sand, gravel, clay, silt, bricks, crushed concrete, wood, wires, other debris.	RO-8A4C5-SO-0507			
				60/24		
-10			RO-8A4C5-SO-1012			
				60/24		
-15	SM	Silty Sand-brown, damp, loose, some wood, gravel, coarse sand.				

SITE MANAGER: M. MEENAN CHECKED BY: K. BELL DRAWN BY: J. FLESCH DATE: 05-20-02 SCALE: N/A CAD DWG. NO.: 8A4C-5 PROJ. NO.: N7551.042D		 TETRA TECH NUS, INC. Houston, Texas	RIVERSIDE OXBOW FORT WORTH, TEXAS SOIL BORING LOG
--	--	---	--

Riverside Oxbow Interim Feasibility Study - C-32

Riverside Oxbow Interim Feasibility Study - C-33

BOREHOLE NUMBER: 8A4C-6 Page 2 of 4						
LATITUDE: 32° 45' 11.518" N LONGITUDE: 97° 17' 17.121" W ELEVATION/DATUM: 526.945' M.S.L.						
PROJECT INFORMATION				DRILLING INFORMATION		
PROJECT: Riverside Oxbow JOB NUMBER: N7551.042D LOGGED BY: K. Bell PROJECT MANAGER: M. Meenan DATE DRILLED: 05-07-02				DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson RIG TYPE: CME-75 METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube TOTAL DEPTH: 60'		
NOTES:				30.00' ▽ Initial Water Level 05-07-02 25.17' ▼ Static Water Level 05-10-02		
DEPTH (Feet)	SOIL SYMBOLS	USCS: SOIL DESCRIPTION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION
-15 -20 -25 ▼ -30 ▽	CL	Silty Clay-brown, caliche, shell fragments, medium stiff, non-plastic, damp, <1% sand, slightly plastic at 18', soft and wet at 28', very soft and saturated at 30'.	RO-8A4C6-SO-1517 RO-8A4C6-SO-2022 RO-8A4C6-SO-2527 RO-8A4C6-ST-2527	 60/60 60/60 60/60		
SITE MANAGER: M. MEENAN CHECKED BY: K. BELL DRAWN BY: J. FLESCH DATE: 05-20-02 SCALE: N/A CAD DWG. NO.: 8A4C-6 PROJ. NO.: N7551.042D			 TETRA TECH NUS, INC. Houston, Texas		RIVERSIDE OXBOW FORT WORTH, TEXAS SOIL BORING LOG	

Riverside Oxbow Interim Feasibility Study - C-36

